Device for storing vehicles.

DESCRIPTION

The invention relates to a device for storing vehicles, which device comprises a plurality of storage locations for said vehicles lying beside and above each other, at least one exchange location connecting to the surroundings of the device, wherein all the aforesaid locations comprise an open supporting platform for supporting a vehicle, means of transport for transporting a vehicle between said at least one exchange location and a storage location, said means of transport comprising a horizontally movable guide system for guiding a lift in vertical direction, which lift comprises a lift platform which can move in horizontal direction between said lift and said locations and which can pass an open supporting platform in vertical direction for transferring a vehicle between the supporting platform in question and the lift platform, said at least one exchange location further comprising a fill-up platform which, in a closed position thereof, in which it is aligned with the open supporting platform of the exchange location, forms a substantially closed surface.

Within the framework of the invention, the term exchange location is understood to mean either an entrance location or an exit location, and it is noted that it is in principle also possible to combine the entrance location and the exit location to form a common location. The entrance location functions as the starting point from where the vehicle in question, normally without any persons present therein, is transported to a storage location by the means of transport. At a later point in time, the means of transport will move the vehicle from said storage location to the exit location, where the vehicle can exit the device. Especially if the vehicle is a car, the driver and any passengers will leave the car at the entrance location and, after some time, return at the exit location of the device, where they will get into

the car again and leave the device using the car. In order to enable persons associated with the car to move around the car at the exchange location in question in a comfortable and safe manner, it is necessary, or at least highly desirable, for the support surface on which the car is present, which also extends beyond the car, to be at least substantially closed, so that persons cannot step into openings that are present in the support surface. This closed nature of the support surface conflicts with the requirement that a lift platform of a lift must be able to pass the support surface for transferring the car. This latter requirement makes it necessary for the support surface to be open to a certain degree.

A device as referred to in the introductory paragraph is disclosed in International patent application WO-A1-99/06655. In this prior art device, the problem of the conflicting requirements made of the support surface at an exchange location is solved by providing a substantially closed deck for a car as well as for persons surrounding the car, which deck consists of two open platform parts which, when they are aligned in a lower position of the two platform parts, form a substantially closed deck. The two platform parts can be moved to an upper position by means of a linkage mechanism, in which position the two open platform parts are positioned at different raised levels, as a result of which a vertical distance is formed between the two platform parts, with the car being present on the upper one of the two open platform parts. The aforesaid vertical distance makes it possible to move an open lift platform of a lift in horizontal direction between the two platform parts, and upon upward movement of the lift platform the car is transferred from the upper platform part to the lift platform when the lift platform passes the upper platform part. The lower platform part can be considered to be a fill-up plate.

After the car has been taken over by the lift platform, it can be placed in a storage location, whose bottom is formed by a supporting platform which, like the above-described upper platform part,

has an open form, so that the lift platform can pass the open supporting platform of the storage location in downward direction for transferring the car from the lift platform to the supporting platform of the storage location. Following that, the lift is available again either for transporting a car from a storage location to an exit location, to which end the above process is carried out in exactly the reverse order, or for collecting a car at the entrance location again and storing it at a storage location.

An important drawback of the prior art device as described above is the constructional complexity thereof at the entrance location and the exit location. Said complexity is in particular caused by provisions such as the linkage mechanism for lifting the two platform parts from the exchange location and moving them apart so as to enable passage of the lift platform between the two platform parts. Another important drawback concerns the safety aspect. In the lower position, the upper side of the supporting platform is level with an entrance road to the supporting platform. Since in the upper position not only the upper platform part of the supporting platform but also the lower platform part of the supporting platform is positioned at a higher level than in the lower position, a hole is formed between the lower platform part and the access road. Thus there is a risk of persons (children, for example) or animals (dogs, for example) somehow falling into said hole and getting hurt or even worse.

It is a first object of the invention to provide a solution for the drawbacks as described above, or in any case realise a significant improvement in this regard. In addition to that, it is an object of the invention, whether or not in preferred embodiments thereof, to provide a device whose constructional characteristics are such that the device can be operated with a high degree of reliability for a period of many years of intensive use.

In the light of the above objects, the device according to

the invention is first characterized in that the fill-up platform can be moved in downward direction from the closed position in order to create space for the lift platform to pass the supporting platform of said at least one exchange location in vertical direction. A first important advantage over the prior art is the fact that it is not necessary to use a separate lifting mechanism at the exchange location for moving the car upwards and downwards. Instead, a mechanism that only needs to be capable of moving the supporting platform up and down and of supporting the car as well for only a very short time during said vertical movement will suffice. The fact is that once the fill-up platform is no longer in alignment with the open supporting platform of the exchange location, the car will be completely supported by the open supporting platform. In addition to the fact that this means a significant constructional simplification, it also means that the cycle time can be significantly reduced because moving the fill-up platform up and down in unloaded condition requires considerably less time than moving an (upper) supporting platform loaded by the weight of the car up and down whilst in the meantime creating or eliminating a spacing between two platform parts of an exchange location, as is the case with the prior art. In addition to that, the invention provides a possibility of making the supporting platform of the exchange location immovable or stationary, so that there will be no risk of a hole being formed between the supporting platform of the exchange location and the area adjacent to said supporting platform. As far as the safety aspect is concerned, it is added that in the unlikely event of a person or animal being present on the supporting platform of the exchange location, the risk of said person or animal getting hurt is smaller when the fill-up platform is moved in downward direction than in the case that one platform part, or both platform parts associated with an exchange location, is (are) moved in upward direction, as is the case with the prior art.

A constructionally simple solution with a view to quickly

creating sufficient space for a lift platform under the open supporting platform, or to quickly forming a closed surface by the fill-up platform is obtained if the fill-up platform can be tilted in downward direction.

A very advantageous embodiment thereof is obtained if the fill-up platform consists of two parts, which can each be tilted in downward direction about a tilting axis that extends parallel to the horizontal direction of movement of the lift platform. On the one hand this achieves that only a limited amount of space needs to be available under the open supporting platform for accommodating the fill-up platform in the swung-down position thereof, whilst on the other hand the tilting axes extending parallel to the horizontal direction of movement of the lift platform, which might also be a central, common tilting axis, make it possible to move the lift platform under the supporting platform of the exchange location in a simple and trouble-free manner.

An optimum situation is obtained if the two tilting axes of the two parts are disposed on two opposed longitudinal sides of the closed surface. The lift platform can move between the two tilting axes and the swung-down parts of the fill-up platform in that case.

As already set forth above, making the supporting platform of the exchange location stationary, i.e. immovable, has major advantages both from a constructional point of view and from a safety point of view.

According to a very special preferred embodiment, the lift comprises a counterweight, which is movable in the direction opposed to the horizontal direction of movement of the lift platform. Thus, the bending moment exerted on the guide system by the horizontal movement of the lift platform can be limited or be reduced to zero.

It is advantageous in that case if control means are provided for controlling the movement of the counterweight in dependence on the weight of a vehicle supported by the lift platform. It can be imagined that the movement of the counterweight will be greater in the case of a heavy vehicle than in the case of a light vehicle, so that the

bending moment exerted by the lift with its extended lift platform supporting a vehicle can be minimised, which reduces the mechanical load, in particular on the guide system, thus increasing the reliability and prolonging the life of said guide system.

A further improvement with regard to reducing a bending moment being exerted on the guide system can be realised if the lift comprises a frame portion which is horizontally movable with respect to a fixed frame portion of the lift, along which movable frame portion the lift platform is movable in horizontal direction. This makes it possible to create a great movability in horizontal direction of the lift platform, so that the lift platform can reach positions located relatively far away from the lift, whilst in addition, if the lift platform occupies a retracted position, the lift platform is positioned at such a point along the horizontally movable frame portion that the centre of gravity of the lift will be located in the axis of the guide system or in the immediate vicinity thereof.

A device which is constructionally simple on the one hand and which is very reliable on the other hand is obtained if the lift is provided with an elongated, flexible tensioning element which is passed over a driving element being rotated by an electric motor for moving the counterweight, the movable frame portion or the lift platform, wherein either the electric motor or the tensioning element is connected to the counterweight, the movable frame portion or the lift platform. Such an elongated, flexible tensioning element may be a toothed belt, for example.

Another constructionally advantageous embodiment is obtained if the guide system comprises four vertical legs disposed near the corners of the lift, which legs are interconnected at their lower sides and at their upper sides, each leg comprising at least three interconnected, parallel leg beams. Said at least three interconnected, parallel leg beams ensure that a very stiff guide system can be realised,

which likewise contributes towards improving the operation and reliability of the device.

Preferably, a further counterweight is movable between the leg beams of a leg so as to enable vertical movement of the lift along the vertical guide. Thus, the space between the leg beams of a leg is utilised in a useful manner.

Stable, horizontal movement of the guide system is possible if a wheel is present under each of the leg beams of a leg for moving the guide system in horizontal direction.

In order to provide a highly reliable movement of the guide system in horizontal direction, it is preferred to fit each leg with an electric motor for driving at least one wheel of said leg.

Even more preferably, each leg is fitted with an electric motor for each wheel thereof for driving all the wheels of the leg.

It is preferred to use an embodiment in which the legs of the guide system comprise no more and no fewer than three leg beams. The three leg beams can be arranged in the form of a triangle, which is in particular advantageous if the guide system is rotatable about a vertical axis so as to enable horizontal movement of the guide system. In such a situation, one side of the triangle may extend along the circular circumference that is described during rotation of the guide system, whilst another side of the triangle extends parallel to the lift, more specifically to the longitudinal direction of the lift.

In order to reduce the noise level during horizontal movement of the guide system, the wheels preferably comprise rubber tyres.

According to another advantageous aspect of the invention, a screening body is present under open supporting platforms, the upper surface of which screening body is preferably slightly inclined so as to effect the discharge of liquids, such as oil, from a vehicle supported by the supporting platform in question to a discharge system. In this way, a

vehicle present at a storage location is prevented from soiling a vehicle present at a storage location positioned thereunder.

A suitable discharge of liquids can be obtained in particular if a discharge gutter, which extends transversely to the direction of inclination of the upper surface, and which is connected to the discharge system, is provided at one end of said upper surface.

It is explicitly pointed out that the preferred embodiments as described above with regard to the lift, more specifically the counterweight and the method of driving the various parts of the lift by means of the elongated, flexible tensioning element, as well as the preferred embodiments of the guide system, in particular in combination with the wheels as described above, as well as the use of the screening body, can also be used independently of each other and of the downward movement of the fill-up platform, as will be immediately apparent to those skilled in the art.

The invention will be explained in more detail hereinafter by means of a description of a preferred embodiment of a device according to the invention, in which reference is made to the following Figures:

Figure 1 is a perspective, partially cut-away view of an automated parking garage;

Figure 2 is a perspective view of the area where cars enter and exit the parking garage;

Figures 3-11 are perspective views of a number of successive situations during automated operation of the parking garage of a limited number of parts of the parking garage that are necessary for a proper understanding of the operation of the parking garage;

Figure 12 is a perspective view of the situation that is shown in Figure 10, exclusively insofar as it relates to the lift system, however;

Figures 13-15 show respective details XIII-XV in Figure 12;

Figure 16 is a perspective view of a wheel assembly.

Figure 1 shows an automated parking garage 1. Said parking garage 1 comprises a tubularly arranged matrix of radially oriented parking locations 2, each suitable for accommodating a vehicle. A lift system 3 is present within the tubular matrix. The lift system 3 comprises a lift 4 which can be moved in vertical direction along a lift guide 5. The lift guide 5 is made up of a framework comprising four vertical legs 6, which are interconnected at their lower sides and their upper sides by longitudinal beams 47 and a cross beam 48 extending transversely thereto, in the centre thereof, and by longitudinal beams 49 and a cross beam (not shown in Figure 1) extending there between.

Each leg 6 comprises three leg beams 7 arranged in the form of an equilateral triangle. One side of the triangle extends in a direction parallel to a longitudinal side of the lift, whilst another side of the triangle extends parallel to the inner circumference of the matrix of annularly arranged parking locations. Present within the triangular shape of the legs 6 are counterweights 8, which are used for moving the lift 4 in vertical direction. The lift system 3 is rotatable about the vertical axis of the tubular matrix of parking locations, on account of the presence of tangentially oriented wheels under each leg beam 7 of each leg 6 and a central bearing 9 in the centre of the cross beam 48.

Figure 16 shows a wheel assembly 10 as present under each leg beam 7. The wheel assembly 10 comprises a wheel 11 of vulcanised rubber which is mounted in bearings on either side. Centrally disposed above the wheel 11 is a mounting plate 12 for mounting the wheel assembly 10 to the leg beam 7. The wheel assembly 10 is furthermore provided with an electric motor 13 for driving the wheel 11.

The lift 4 comprises an extensible lift platform for vehicles, thus enabling, in a manner yet to be described in more detail, automated delivery or receipt of vehicles at a specific parking location. Since the lift 4 is capable of vertical movement and the lift guide 5 is

capable of rotating movement, all parking locations 2 can be reached.

Figure 2 shows part of the lower side of the parking garage 1, viz. the area where cars 14 can enter and exit the parking garage 1. To that end, an entrance road 14 as well as an exit road 15 are provided. The parking garage 1 is provided with an entrance location 16 at the end of the entrance road 14, whilst an exit location 17 is present at the beginning of the exit road 15, which exit location is largely hidden from view by the covering 18 above the entrance road 14 in Figure 2. A covering 51 is likewise present above the exit road 15. The entrance location 16 and the exit location 17 of the parking garage 1 are identical as regards their construction, as will become apparent yet hereinafter.

Figure 3 shows (parts of) components of the parking garage 1, with reference to which, and also with reference to Figures 4-11, the automated operation thereof will be explained. The lift 4 comprises an elongated cage construction 19 having an open front side 20, through which cars can be moved into the cage construction 19.

The lift 4 is to that end provided with an arm 21, which is movable along the bottom of the cage construction 19, in the longitudinal direction thereof, over which arm a lift platform 22 for cars is in turn movable. Thus it is possible to move the lift platform 22 of the lift 4 to an identical radial position as a supporting platform 23 of a parking location. Such an extended position is shown in Figures 6, 9 and 10.

The lift platform 22 of the lift 4 comprises a central mounting beam 24, which extends in the longitudinal direction of the lift 4 and from which regularly spaced tubes 25 having free ends extend on either side of the supporting beam 24, perpendicularly to said longitudinal direction. Said tubes 25 function to support the wheels of a car (not shown). The shape of the supporting platform 23 of a parking location 2 is substantially complementary to that of the lift platform 22: the supporting platform 23 comprises two spaced-apart parallel

mounting beams 26, from which tubes 27 having free ends extend perpendicularly to said beams 26. The shape of the supporting platform 23 and that of the lift platform 22 are such that the lift platform 22 can pass the supporting platform 23 in vertical direction, during which passage the supporting beam 24 of the lift platform 22 is positioned between the free ends of facing tubes 27 of the supporting platform 23, seen in top plan view, whilst the tubes 25 of the lift platform 22 are positioned between adjacent tubes 27 of the supporting platform 23.

A counterweight 32 is movable in longitudinal direction along the upper side of the cage construction 19. By moving said counterweight 32 in a direction opposed to the direction of movement of the lift platform 22 supporting a car, it is possible to achieve or approximate an equilibrium of moments, so that the mechanical load being exerted on the lift guide 5, or more specifically on the legs 6 thereof, can be significantly reduced.

Figure 12 for example shows the lift platform 22 in an extreme extended position thereof, in which the counterweight 32 occupies its extreme position on the opposite side. The counterweight 32 is provided with an electric motor, which drives a toothed wheel 33 (see Figure 14) for moving the counterweight. Present under the toothed wheel 33, on either side thereof, are two pulleys 34, 35, whose axes of rotation extend parallel to that of the toothed wheel 33. A flexible toothed belt (not shown) extends between the front side and the rear side of the cage construction, within the gutter 36. The toothed belt is passed over the pulleys 34, 35 and the toothed wheel 33 in the manner that is shown in Figure 13, with the teeth of the toothed belt meshing with the teeth of the toothed wheel 33. When the electric motor is driven, the toothed wheel 33 will be rotated, causing the counterweight 32 to move along the toothed belt. It is conceivable in this connection to use a control system (not shown) that makes the degree of movement (partially) depend on the weight of the car being supported by the lift

platform 22. Thus the extent of movement of the counterweight 32 will be greater in the case of heavy cars than in the case of light cars, thereby making it possible to approximate an equilibrium of moments as closely as possible.

A comparable solution is provided for the movement of the lift platform 22 with respect to the extensible arm 21. The lift platform 22 is provided with a toothed wheel 37 to be driven by an electric motor (not shown), and with two pulleys 38, 39. A toothed belt 40 extending from the front side of the extensible arm 21 to the rear side thereof is passed over said toothed wheel 37 and said pulleys 38, 39.

The situation as regards the way in which the extensible arm 22 is driven with respect to the cage construction 19 is different to a limited extent, in the sense that it is not the extensible arm 21 but the cage construction 19 itself that is centrally provided with a toothed wheel that can be driven by an electric motor 41 via a transmission 42, above which toothed wheel two pulleys 43, 44 are positioned on either side thereof. The extensible arm 21 is provided with a second toothed belt 45 extending parallel to the toothed belt 40, which second toothed wheel is passed over the toothed wheel (not shown) and the associated pulleys 43, 44. When the electric motor 41 is driven, it is not the electric motor with the parts being rigidly connected thereto that will move along the second toothed belt 45, but instead the toothed belt 45 with the extensible arm 21, including the lift platform 22, will move past the electric motor 42. Said extending of the extensible arm 21 can take place on either end side of the cage construction 19.

Like the parking locations 2, the entrance location 16 is provided with a supporting platform 28, whose construction is nearly identical to that of the supporting platform 23 of the parking location 2, with this understanding that the facing tubes 29 of the supporting platform 28 are of square cross-section, extending along the full length of the supporting platform, whereas the tubes 27 of the supporting

platform 23 are only present at those positions where wheels of a car are expected to be supported.

Present at the entrance location 16 are also two swung-down floor members 30, 31. In the raised position (as shown in Figure 3), said floor members 30, 31 jointly have the shape of the lift platform 22, with this understanding that the shape thereof, which is complementary to the shape of the supporting platform 22, is continued even further, so that the floor members 30, 31 and square tubes 29 together form a substantially closed surface, apart from a few narrow seams, thus enabling persons to move around a car present at the entrance location in a safe and comfortable manner.

The floor members 30, 31 can be tilted about tilting axes extending at the longitudinal sides of the entrance location 16 by means of hydraulic tilting mechanisms; the tilting mechanism 32 for the floor member 30 is shown in Figure 3. The swung-down position of the floor members 30, 31 is shown in Figure 4, for example. It will be understood that the floor members 30, 31 must not be swung down until all persons and animals have left the entrance location and access to the entrance location 16 is no longer possible. Suitable sensors (not shown) can be used to establish whether persons and/or animals are still present at the entrance location, whilst persons and/or animals are prevented from entering the entrance location, by means of doors (not shown) that are closed after said persons and/or animals have left the entrance locations, while the floor members 30, 31 are (being) swung down.

As can be seen in Figures 1 and 2, for example, a screening body 52 having the shape of a hooked Ω, seen in vertical cross-sectional view, is present above each parking location 2. The upper horizontal plane of said Ω-shape catches dirt from a car that is present on the supporting platform of a higher parking location 2, thus protecting a car that is present under the screening body 52. Said dirt, such as leaking oil, is laterally discharged from the upper horizontal plane of the Ω-

shape to the lower horizontal portions of the Ω-shape, which are in turn connected to a discharge system (not shown).

The operation of the automated parking garage 1 is as follows. A car 50 approaches the parking garage 1. Once the control system 1 has established that the floor members 30, 31 are in the raised, horizontal position and that no car is present at the entrance location 16, the cage 46 is opened, so that the car driver can drive onto the closed surface formed by the floor members 30, 31 and the supporting platform 28 of the entrance location via the entrance road 14. The driver and any passengers then get out of the car and leave the entrance location 16, which is subsequently closed by means of a second gate (not shown) present at the end of the covering 18. Once this gate is closed, the floor members 30, 31 swing down (Figure 4), as a result of which sufficient space is created between the two floor members for positioning the end of the extensible arm 21 and the lift platform 22 there between, with the tubes 25 of the lift platform 22 being positioned precisely between the tubes 29 of the supporting platform 28 of the entrance location 16 (Figure 5), seen in top plan view. Vertical movement of the lift 4 along the lift guide 5 achieves that the lift platform 22 passes the supporting platform 28 of the entrance location 16, taking over the car 50 from the supporting platform 28 during said passage (Figure 6). Subsequently, the arm 21 and the lift platform 22 move back again until the lift platform 22 is positioned in the centre of the lift 4. Rotation of the lift guide 5 and vertical movement of the lift 4 along the lift guide 5 make it possible to align the lift 4 with each parking location 2. For the sake of simplicity, the lift 4 is aligned with a parking location 2 which is disposed above the entrance location 16 in Figure 8. The level at which the lift 4 is present at that point is such that the lift platform 22 extends just above the supporting platform 23 of the parking location 2, whilst the extensible arm 21 extends just below said supporting platform 23. After the extensible arm 21 and the lift platform

22 have been extended (Figure 9), the lift 4 will move to a lower level, during which movement the lift platform 22 passes the supporting platform 23 of the parking location 2 and the car 50 is transferred from the lift platform 22 to the supporting platform 23 (Figure 10). Subsequently, the extensible arm 22 and the lift platform 22 return to their original position (Figure 11) and the lift is available again either for collecting a next car from the entrance location 16, or for collecting a parked car from another parking location 2 and delivering it at the exit location 17. The latter process takes place in exactly the reverse order of the process that has just been described. Although the floor members 30, 31 are shown in a swung-down position in Figures 7-11, it is also possible for the floor members 30, 31 to be raised already in these situations for supporting a next car.